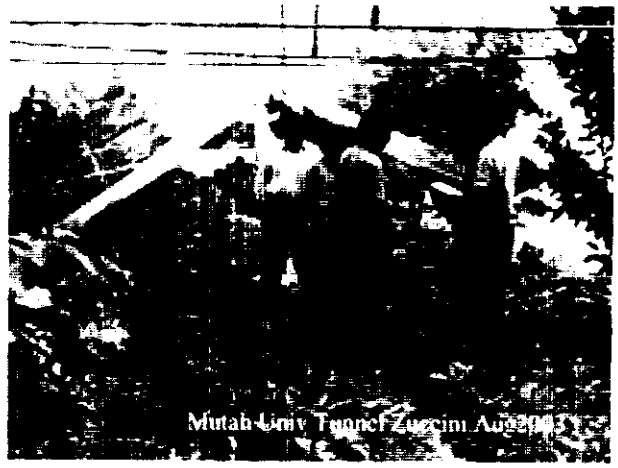
PN-ACW-524

Semi-Annual Report

Covering period from: July 2003 to December 2003



Observations at Mutah Univ.
Zucchini Plastic Tunnel Aug2003

Comparing the efficiency of native and domesticated bees in the pollination of field and orchard crops

(Second) Semi-Annual Report

Covering period from: July 2003 to December 2003

Submitted to the U.S. Agency for International Development; bureau for Economic Growth, Agriculture and Trade

Comparing the efficiency of native and domesticated bees in the pollination of field and orchard crops

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Executive Summary:

Project purpose: Improving crops pollination through advancement of applied Pollination Techniques and investigating the potential for using new, additional, insect pollinators in Jordan and Israel.

Important Notes:

1. Failure of crops growth at several plots in Jordan: Unfortunately, in some of the plots planted, the plants failed to grow (see table in Appendix). Causes include surplus or shortage of irrigation, or other inadequate agro technical management. The implications include delay of the plan and future more detailed agro technical management training for the growers.

Jordan:

- ✓ Along the reported period, we continued studies of crops' pollination, started before July 2003. Also, some new plots of cucurbits were planted to assess the value of summer crops in the high regions of Jordan.
- ✓ Seedlings, including advanced varieties of grafted watermelon, had been imported from Israel (ca. 6,000 seedlings).
- ✓ Yield in apples, concluded at the end of November, showed significant contribution of wild pollinators.
- ✓ Novel application setup of Honeybees, Mini-Hives ("Nucs"), for pollination of small plots with honeybees were established at open field and under cover growth and monitored for developmental status and sustainability.

Israel:

✓ Wild Pollinators Research Activities: At the Israeli side, we conducted Research Activities at the net house, erected in the "BeeHave" - Prof. Shmida lab in Jerusalem, where Carpenter Bees' (Xylocopa) preferences and behavior have been studied until the end of September. Currently, those studies continue in a Heated Greenhouse at Achva College Campus, the coastal plain. While writing the report, temperatures are falling and we enter a period along which we will try to maintain active Xylocopa nests at Achva site.

✓ Artificial Nests of Xylocopa had been collected at the end of December, from 6 sites and transferred to two locations, where wormer climate will favor higher success rate of overwintering.

✓ The Xylocopa preferences for nesting substances will be summarized in the next report.

✓ Comparing the efficiency of Bumblebees and Honeybees (regular Hives and "Nucs" Mini-Hives) in pollinating Zucchini in net tunnels started September in the Israeli Arava Valley.

✓ Honeybees' Mini-Hives ("Nucs"), a novel application setup of honeybee hives is under pilot study at both the Jordanian and Israeli sides. A protocol for monitoring those relatively sensitive colonies was written and is currently tested.

Section I

Research Objectives and findings:

Jordan:

Studies of crops' pollination: Along the reported period, we continued studies of crops' pollination, started before July 2003, conducted at the Experimental Stations (Al-Shoubak, Rabba), Faculty of Agriculture of Mu'tah University (see table in appendix) and some private farms. Also, some new plots of cucurbits (Melon, Watermelon and Zucchini) had been planted to assess the value of summer crops in the high regions of Jordan with seedlings brought from Israel. All at all about six thousands (6,000) seedlings had been imported from Israel. We would like to emphasize the import of grafted watermelon varieties, which are currently the advanced cultivars.

Apples' Yield: At Al-Shoubak station apples' orchard, measurements of first season yield in apples, concluded at the end of November (see Table No. 5 in appendix). Comparison of Fruitset percentage and fruits' weigh between insect pollinated branches and control (bagged) branches shows that in all cultivars insect pollination, mainly by wild pollinators (since honeybees had been introduced too late), contributed majority of fruit set and yield. The percentage of fruitset in bagged branches could be due to self compatibility and spontaneous self-pollination. Anyway, we will study the relative commercial value of different cultivars to choose some for more detailed study. Other parameters will be analyzed and presented in next report.

Mini-Hives ("Nucs"): Honeybees' Mini-Hives ("Nucs"), a novel application setup for pollination of small plots with honeybees (see below), were established at open field and tunnels at A-Rabba region (Mu'tah University site) and monitored for pollination activity, developmental status and sustainability.

Israel:

Wild Pollinators Research Activities: At the Israeli side, we conducted Research Activities at the net house, erected in the "BeeHave" - Prof. Shmida lab in Jerusalem, where Carpenter Bees' (Xylocopa) preferences and behavior have been studied until the end of September. Currently, those studies continue in a Heated Greenhouse at Achva College Campus, the coastal plain. While writing the report, temperatures are falling and we enter a period along which we will try to maintain active Xylocopa nests at Achva site.

Artificial Nests of Xylocopa had been collected at the end of December, from 6 sites and transferred to two locations in the coastal plain (Kibbutz Yad-Mordechai and Achva College) and to Ein-Gedi (Dead-Sea Valley). At all sites, we expect the wormer climate will favor higher success rate of overwintering. The Xylocopa preferences for nesting substances will be summarized in the next report.

From September on we started an experiment in the Israeli Arava Valley, at Neot-Hakikar just opposite the Jordanian Ghor Al-Safi site, and at Ein-Yahav, some 30 Km. South, at the middle of the Arava Valley. At both sites we compare the efficiency of Bumblebees and Honeybees (in regular Langsthroth Hives and "Nucs" - Mini-Hives) pollinating Zucchini within net tunnels under Organic Growth agro technical management.

Honeybees' Mini-Hives ("Nucs"):

Novel application setup of honeybee hives, namely Mini-Hives ("Nucs") is under pilot study testing at both the Jordanian and Israeli sides. These "Nucs" are potential answer to the known problem of applying honeybee colonies to pollinate crops under cover (tunnels, glasshouses, net houses), or open fields and orchards, in areas smaller than about 3000 m^2. In such small areas, the flowers' reward can not supply the colonies' needs and they deteriorate, or, in open areas, fly away to search for food. This complication is important issue in pollination experiments that, naturally, are conducted in small plots. We suggest here a novel approach to this problem. We applied mini-hives for pollination under the said conditions in tunnels at Mu'tah University Site. Usually mini-hives are used solely for breeding purposes.

A protocol for monitoring the conditions and development of those relatively sensitive colonies was written and is currently tested.

Primary results from the Mu'tah University Site and the beginning of the growth season in Neot-Hakikar and Ein-Yahav, show good pollination performance and sustainability of the Nucs.

Future Work: (Until next semi-annual report),

Pollination Studies: Pollination Studies will be conducted along winter and spring seasons at the undercover cucurbits plots in the Israeli side, emphasizing comparisons of the different pollinators' (regular Honeybee hives, Honeybee Minihives Nucs and Bumblebees) efficiency. We will continue to test and develop the protocols for inspecting and monitoring hives conditions and pollination efficiency.

Apples' orchards: An effort will be devoted to prepare the study along coming blooming season of Apples' orchards at Al-Shoubak Res. Station area. We will contact local commercial growers trying to study pollination under practical agricultural conditions.

Pollination in Open field areas: We plan to get access to cucurbits and tomatoes plots at open field areas in Ghor-Al-Safi region and also to undercover growth of Cucurbits, Tomatoes and Pepper in Al-Haq Farms' Um-Mitleh Station. In both locations, we will be able to compare different pollinators' efficiency, again under practical agricultural conditions.

Honeybees' Mini-Hives ("Nucs"): The pilot study of this novel application setup of honeybee hives will be continued at both the Jordanian and Israeli sides, the protocol for monitoring the Nucs will be used and modified as necessary.

The mini-hives are not available in Jordan and will be purchased in Israel, prior to shipping to Jordan.

Wild Pollinators Research Activities:

Experiments with Xylocopa nests' sustenance at Achva (heated greenhouse) and Yad-Mordechai sites will be conducted until midst of spring as well as in Ein-Gedi.

Expected success of those experiments in the heated greenhouse in Achva College campus, will enable us to transfer nests to plots in Jordan next spring.

We expect Ein-Gedi to be the main source for active nests to be used for experiments in Jerusalem and Achva along next spring.

We will continue to study Xylocopa nesting materials preferences in Kibbutz Yad-Mordechai and Ein-Gedi, while studies of Xylocopa foraging preferences and pollination efficiency will be conducted at Achva College with Melon.

Next spring, Osmia artificial nests, recently purchased from Oxford Univ. will be installed in Shoubak and Jerusalem.

Section II, Managerial Issues:

Budget:

Along the reported period we conducted four visits to Jordan, as our experience taught us that for keeping good contact and efficient cooperation, frequent visits are a must (see this section at former report).

Collaboration, Travel and Training

Table 1: Collaboration, Travel and Training - Activities' Summary, , ,

Date	Location	Activity & Collaborators
22-23 Jul 2003	NCARTT Res. Stations at Al-Shaubak, A-Rabba and Al-Mutah University and Magdalena (Bashapsi Farm) Jordan	Visit to Jordan: Prof. Shmida, Mr. Ravid, Mr. Weil, Mr. Shihadeh. Watermelon and Zucchini planting at A-Rabba. Magdalena (Bashapsi Farm). Visit and planting open filed and plastic tunnel at Al-Mutah University.
20-25 Aug 2003	NCARTT Res. Stations at Al-Shaubak, A-Rabba and Al-Mutah University, Jordan	Visit to Jordan: Prof. Shmida, Mrs. Adiv, Mrs. Reuben, Mr. Ravid, Mr. Shihadeh Watermelon and Zucchini planting at A-Rabba, replanting at Al-Shoubak. Studying zucchini phenology. Introducing Mini-Hives into plastic tunnel at Al-Mutah University.
19-21 Nov 2003	NCARTT Res. Stations at Al-Shaubak, A-Rabba and Al-Mutah University, Jordan	Visit to Jordan Prof. Shmida, Mrs. Adiv, Mrs. Reuben, Mr. Ravid, Mr. Shihadeh Testing protocol for Mini-Hives, summarizing experiments and plan for next year. Meetings with colleagues in NCARTT
21-23 Dec 2003	NCARTT Res. Station at Maru, Jordan	Visit to Jordan Prof. Shmida, Mrs. Reuben, Mr. Shihadeh, Dr. Nizar Haddad, Mr. Omar. Plans for next year, training in field measurements.

Appendices

1. Table of Planted Plots in Jordan

2. Pictures

3. Results Examples Tables 2 -5

4. Protocol for Monitoring Honeybee Hives and Mini-Hives

Table 2: Planted Plots in Jordan

Plot	Crop	The planted cultivar:	Planting date:	Number of rows	Number of plants	width	length	The planted area: -
Al-Rabba **First location**: Near rest house.	Watermelon	*crimson sweet (male)*	13/4/2003	10	91	15	22	330m²
	Melons	Female 313	3/6/2003	3	36 & 7 male	4.5	22	99m²
[1]	Squash	*Tzuk*	3/6/2003	5	54	7.5	22	165m²
Al-Rabba Second location: - in Al-Rabba station, near Prince Zaid school.	Melons	(female) 313	15/4/2003	10	68 grown by seeds			
[2]	water melon	crimson sweet (male)	15/4/2003	8	139	12	22	264m²
Al-Rabba Third location: - Private farm, owner (Nahar Al-majali) in Al-Rabba 3Km far from Al-Al-Rabba station	Squash	Tzuk	3/6/2003	6	119			
	Melons	(female) 313	3/6/2003	17	196 seedling. & 36 male			

[1] Note: - Replanted was made for 43 squash seedlings in 3/6/2003

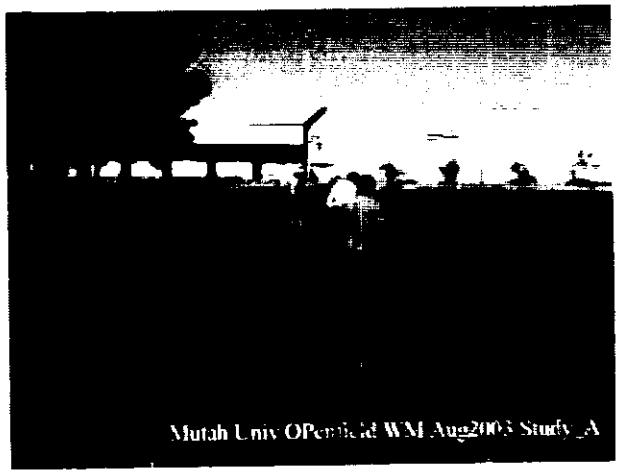
An important note:-
Distance between rows (1m), between seedlings (1.5m)
The whole area for this planted area (32m) width * (22m) length = 704 m²

[2] Distance between rows (1m), between seedlings (1.5m)
The whole area for this planted area (42m) width * (22m) length = 924 m²

Plot	Crop	The planted cultivar:	Planting date:	Number of rows	Number of plants	width	length	The planted area: -
Al-Rabba Fourth location: Magdalena (Bashapsi Farm) Al-Rabba Region	Zucchini (Kussa)			4	232	1	23	100m²
Al-Rabba Fourth location: Magdalena (Bashapsi Farm) Al-Rabba Region	Watermelon	Crimson,		2	54	1	23	50m²
Al-Rabba Fifth location: Mu'tah University Open Field Plot	Watermelon	Crimson, Seedless + Crimson	July 2003	6	550	15	100	1500m²
Al-Rabba Fifth location: Mu'tah University Plastic Tunnel	Zucchini (Kussa)	Erlica	July 2003	2	250	4	25	100m²
Al-Qassr Private Farm (Na'hr)	Watermelon	Crimson		6	120		15	
Al-Qassr Private Farm (Na'hr)	Zucchini (Kussa)			2	30		15	
Al-Shaubak station	Squash:	Tzuk	4/6/2003					
	Melon	(Female) 313	4/6/2003	4	284 seedling & 45 males			Distance between seedling:-40cm

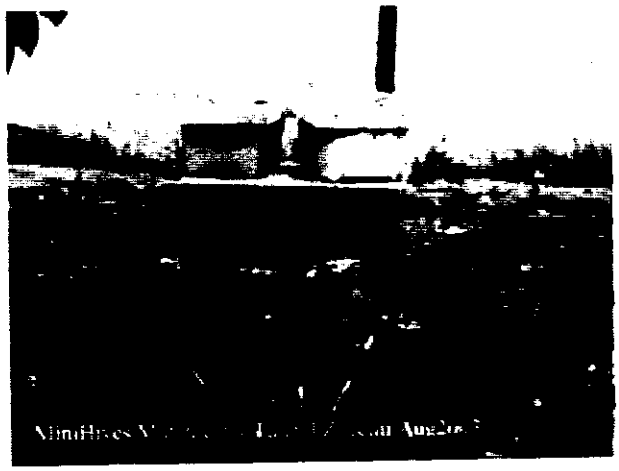
2. PICTURES

Planting at Bashapsi Farm Aug2003

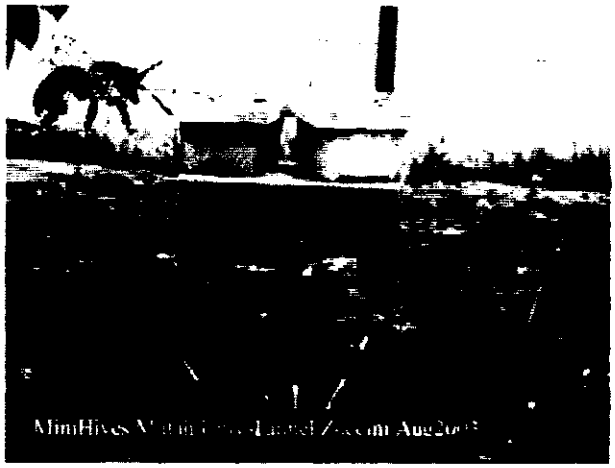


Observations at Mutah Univ OPenfield WM Aug2003

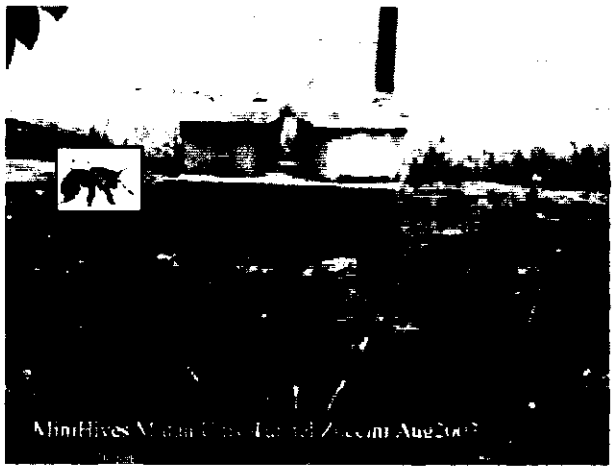
Observations at Mutah Univ
Zucchini Plastic Tunnel Aug2003



MiniHives Mutah Univ
Zucchini Plastic Tunnel Aug2003



MiniHives Mutah Univ
Zucchini Plastic Tunnel Aug2003



MiniHives Mutah Univ
Zucchini Plastic Tunnel Aug2003

The first time in the world that mini-hives have been used for pollination

(Mutah University, Raba, Jordan)

Table 3: An example of observations on flower reward and bee foraging activity in Zucchini open field at A-Rabba St.

Zucchini A-Rabba St. 20 Aug. 2003

Time	NP (Nectar production)		NSC (Nectar Standing Crop)		Flower Bee Visit in 10 Min.		Number bees entering with pollen	Bees Activity Number bees entering per min.
	Male Flower	Female Flower	Male Flower	Female Flower	Male Flower	Female Flower		
5:00	0	5.63	0	5.63				
5:30	0	75.2						
6:30					0.5	4		
7:30							6	3
8:00	0	31.13	0.008	0.004				
9:00							11	6
10:00	0.36	86.5	0	0	0	0	2.5	0.75

Table 4: An example of yield comparison between honeybee and bumblebee pollinated Zucchini plots in Neot-Hakikar, Israel

Neot-Hakikar * Zucchini, 2003 cycle I

Harvest - Comparing Bumblbees and Honeybees

Plots 1-10 harvest

	Pollinator \ Plot	*Fruit* Weigh gr.	*Days from* Pollination	Fruit length cm.	Fruit diameter cm.
November 7, 2003	Bumblebees	173.8	4.5	16.2	3.5
November 8, 2003	Bumblebees	183.8	4.9	16.2	3.5
November 9, 2003	Bumblebees	191.3	5.3	16.6	3.6
	Bumblebees Avera	**183.0**	**4.9**	**16.3**	**3.5**
November 7, 2003	Honeybees	171.1	4.4	16.2	3.5
November 8, 2003	Honeybees	188.1	4.7	16.3	3.7
November 9, 2003	Honeybees	185.8	4.5	16.1	3.6
	Honeybees Averag	**181.7**	**4.5**	**16.2**	**3.6**

Table 5: Al-Shoubak station apples' orchard -
Comparing fruitset percentage and fruits' weight between unpollinated and insect pollinated branches

Al-Shoubak station apples' orchard

Comparing fruitset percentage and fruits' weight between bagged and unbageed branches per cultivar

Number	Cultivars	Bagged		Opened	
		Fruitset % of *potential* Covered Br.	Average Weight g	Fruitset % of potential Uncovered Br.	Average Weight g
6	Adeina	0.7%	25.0	0.3%	75.0
19	Akaane	0.4%	75.0	9.3%	94.9
17	Belrenah	0.6%	62.5	16.2%	97.4
1	Ein shameer	1.3%	12.5	8.7%	45.0
2	Golden Anna	0.0%	0.0	9.6%	87.3
13	Golden delicious	1.1%	0.0	13.1%	86.6
3	Golden Dorset	0.4%	13.8	23.9%	106.3
9	Granny smith	1.3%	0.0	8.8%	99.8
5	Granny spear type	0.8%	68.8	8.0%	237.1
7	Greasy make	6.2%	47.5	26.7%	140.0
18	helter red	38.9%	1.4	54.1%	1.7
21	Jonathans	0.4%	102.5	14.8%	119.2
20	Nagava 6		4.0		85.6
12	Pioneer	0.8%	9.2	18.1%	65.1
8	Red melia	2.0%	98.5	7.5%	87.0
14	Red miracle	2.6%	12.5	26.6%	138.6
15	Royal gala	0.7%	12.5	10.1%	55.2
16	Spear golden delicious	1.9%	29.4	13.1%	98.1
10	Summer red	0.5%	50.0	5.3%	100.0
11	Tougaroo	0.5%	22.5	2.2%	87.1
4	Vestapla	1.4%	25.0	14.6%	54.4

Avi Shmida Sayfuddin Shihade, Noga Reuven & Kutzi:
Tasks' List Sheet Nov. 2003


Monitoring Honeybee Hives and Mini-Hives

Introduction: This tasks' list aims to supply a tool to monitor and assess the condition of Honeybee Hives and Mini-Hives (Nucs, "YAARIOT").

Schedule: Once a week on the same day.

Equipment: Bee suit, Bee veil, Gloves, Hive Tool, Smoker.

Preparations: Mark individually each hive.

External Observations:

General Condition:
Observe the entrance to the hive and vicinity. Look for any abnormal phenomena like dying and\or convulsive bees, thrown out brood, malformed bees etc..

Hive Weight:

Foraging Activity:
At peak of daily activity (commonly 09:00 AM to 12:00 AM), Stand near the hive so you have good view of the entrance. DO NOT stand in front of the hive, where you disturb the bees. Count entering foragers during two minute. Count bees coming in with and without pollen loads. Use counters. Repeat counts twice.

Internal Observations:

To be conducted **AFTER** completing external observations.

Preparations:
Apply small dose of smoke to the entrance only.

Marking Combs – the first time you open the hive number the combs with a marker and mark direction of each comb, so you'll be able to discriminate between comb sides (a,b).

Monitor Population Condition
Open the Hive carefully, with minimal disturbance to the bees. Observe the combs from above. Estimate and write down number of populated combs (= between combs spaces filled with bees).

Monitoring Brood condition

Take out combs, one by one, assess sealed brood area on both sides by square decimeters (10 square centimeters), use transparent plastic sheet with grid marked on.

Note and write down presence of open brood, including eggs and larvae.

Note and write down presence of Honey and Pollen storage cells.

If no open brood present, try to find the queen.

Note and write down presence of "wild combs", means combs built outside the frames, in other spaces of the hives (in feeders, under the cover etc.).

Follow Up

Compare results to former inspections. Try to see trends of development or deterioration.

Table 1.: External Observations **Before** Opening the Hive

Hive ID.:_____
Write Data or Mark Choices

Hive Weight gr.			
Within greenhouse Exceptional bees' behavior: Under ceiling or near walls crowding	near walls	Under ceiling	None
Near Hive Entrance Exceptional bees' behavior: Sick, Dead Bees, thrown out garbage, chalk brood (number) _____	_____ Dead	_____ Sick	None

Entering Bees' Count	Time _____	Time _____	Time _____	Time _____
Number of bees entering in 5 minutes				
Number of bees entering with pollen loads (part of overall count)				

Table 2.: Internal Observations:
2a. Regular Honeybee Hive (10 combs)

Hive ID.:_____

	BROOD		POLLEN	HONEY	
Comb No. & Side (a\b)	Sealed Brood % of Comb Area	Open Brood % of Comb Area	Pollen Storage % of Comb Area	Sealed Honey % of Comb Area	Open Honey % of Comb Area
1a					
1b					
2a					
2b					
3a					
3b					
4a					
4b					
5a					
5b					
6a					
6b					
7a					
7b					
8a					
8b					
9a					
9b					
10a					
10b					

Table 2b.: "Nuc" MiniHive Honeybees (4 combs)

Hive ID.:_____

	BROOD		POLLEN	HONEY	
Comb No. & Side (a\b)	Sealed Brood % of Comb Area	Open Brood % of Comb Area	Pollen Storage % of Comb Area	Sealed Honey % of Comb Area	Open Honey % of Comb Area
1a					
1b					
2a					
2b					
3a					
3b					
4a					
4b					